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Title of Invention: HEAT TUNNEL FOR FILM SHRINKING

Background of the Invention

This is a continuation-in-part of co-pending U.S. Patent Application Serial No. 60/473,372, filed May 23, 2003.

The present invention is directed to an apparatus for packaging articles using shrink-wrap film, and particularly to an improved heat tunnel that can be used for various film configurations.

It is known in the art to overwrap articles in a web of heat shrinkable film to form a multipack package by separating a tube of such film wrapped around spaced groups of articles along a weakened zone by shrinking the tube adjacent the zone and then by shrinking the tube section formed thereby around the articles to form a package. See U.S. Patent No. 3,545,165.

Previous methods of packaging such as the above have involved feeding the groups of articles into a heat tunnel in series, with the film wrapped around the articles from the leading edge of the group to the trailing edge of the group. Fig. 1 shows how this is typically accomplished. Groups G of articles A are placed spaced apart on a conveyor C A layer L of film F (usually from a roll of film) is wrapped around the groups G with the film layer L continuously covering adjacent groups G.

The groups G are then fed on the conveyor into a heat tunnel T. Heat and (typically) forced air is applied to the junction J between adjacent groups, causing the film layer L to soften at the junction J and pinch off between the groups, at the same time shrinking tightly against the groups G as shown. This results in complete packages P of articles A, with the film shrunk about them. The closed ends E of the packages (known as "bulls eyes") are at ends of the packages in the direction of travel of the conveyor (shown by the arrow).

An extension to the above apparatus is shown in Fig. 2. Here, parallel conveyors C1, C2, C3, etc. carry article groups G1, G2, G3, etc. into the heat tunnel, where the above-described heat-shrinking occurs. The parallelism improves total throughput.

The apparatus shown in Figs. 1 and 2 has a number of disadvantages. In gathering of multiple articles A into the groups G (known as "pack patterns"), the continuous tube of film creates design challenges to support the groups from the underside while the tube of film is formed around the product. This is further complicated by product size changeover requirements. Theoretically, the conveyor C that transports the product pack pattern into the

heat tunnel would have to change widths for each change in product size to accommodate the tube of film around the pack pattern.

In yet another variation (which Applicant has used in the past), cut sleeves of film are used, one sleeve per article group, instead of a continuous layer of film around the groups. However, the groups G are fed serially into the heat tunnel T with the articles in each group G oriented in such a manner that the film will be shrunk around each group with the resulting closed ends E ("bulls eyes") oriented transverse to the direction of travel of the conveyor. To improve throughput, multiple parallel streams of articles may be fed into the heat tunnel.

U.S. Patent Application Serial No. 60/473,372 discloses an apparatus and method for packaging articles using tubes of pre-perforated shrink-wrap film, with the tubes of pre-perforated shrink-wrap film enclosing the articles fed into a heat tunnel on a conveyor, the open ends of the tubes of film being oriented substantially transverse to the direction of motion of the conveyor.

The present application discloses an improved heat tunnel for use with both pre-perforated and non-preperforated shrink wrap film.

In the packaging industry, aesthetics has become an increasingly important issue, both for the package that is produced and the machine that produces it. When the film is shrunk around the end of a package, it should leave a circular opening, the “bulls eye”, and should be free of wrinkles. This should be consistent from package to package and over a variety of product sizes.

Many of the challenges in producing aesthetically pleasing “bulls eyes” stem from the way that current heat tunnels operate. Current heat tunnels often produce deformed bulls eyes due to uncontrolled airflow. That is, as the group of articles enclosed in shrink-wrap film enters the heat tunnel, the film is subjected to various disruptive air currents, causing the film to flutter as it is shrunk. This uncontrolled airflow results in the film wrinkling and shrinking non-uniformly, which in turn results in unaesthetically pleasing bulls eyes. Furthermore, current heat tunnels are not generally adjustable for various product sizes.

There is a need for a new heat tunnel capable of consistently good bulls eyes with controlled shrink and that is adjustable for a range of product sizes.

There is also a need for a new heat tunnel to reduce the heat transfer to the outer skin of the heat tunnel, increasing the operating efficiency and improving the working environment around the machine by lowering the temperature.

There is also a need for a more aesthetically appearing heat tunnel, and one of reduced size.

All of the above needs are addressed by the present invention.

Summary of the Invention

A heat tunnel for applying heated air to articles to enclose the articles in shrink-wrap film, the heat tunnel comprising:

(a) at least one air supply unit, the air supply unit further comprising a source of heated air, a fan, a heated air plenum, air ducts, and a return air plenum;

(b) a conveyor chain; and

(c) a heat shroud spaced from the conveyor chain

wherein multiple air supply units can be provided along the conveyor to create a heat tunnel of desired length.

A principal object and advantage of the present invention is that it provides a balanced laminar flow of air through the conveyor and controlled airflow from the sides. This creates shrink film covered packages with consistently shaped bulls eyes, minimum distortion of graphics, and a minimum of wrinkles.

Another principal object and advantage of the present invention is that it permits vertical adjustment of the heat shroud to ensure consistent results over a range of product sizes.

Another principal object and advantage of the invention is that the heated air passing through the conveyor web contacts the film under the product and results in an "air weld" of the film lap seam.

Another principal object and advantage of the invention is that the heated air has a minimum contact with the product conveyor chain web, so that the chain can be maintained at a relatively cool temperature of about 220° F. As a result, the film does not stick to the chain and less heat energy is lost to the environment.

Another principal object and advantage of the present invention is that the outer surface of the heat tunnel stays cooler during operation, thus making the machine safer and more comfortable to work around and also increasing operating efficiency due to the reduced heat loss.

Another principal object and advantage of the present invention is improved appearance, with a curved heat shroud and a lower profile.

Another principal object and advantage of the present invention is that the conveyor is adjustable to use either side-by-side cut tubes of articles or articles enclosed in pre-perforated shrink wrap film.

Another principal object and advantage of the present invention is that it can be used with a single chain conveyor the full width of the machine or with multiple chains running side by side with center air ducts.

Another principal object and advantage of the present invention is that the conveyor construction allows air from the heated air plenum to freely pass through it to the product.

Another principal object and advantage of the present invention is that the chain temperature is controlled by a cooling fan that circulates air across the full width of the conveyor chain.

Another principal object and advantage of the present invention is that it produces a sound reduction of approximately 13% compared to previous models.

Another principal object and advantage of the present invention is that the OEM rated service life of the heaters is in excess of 20,000 hours of operation.

Another principal object and advantage of the present invention is that it provides modular air supply units having a source of heated air, a fan, a heated air plenum, air ducts, and a return air plenum, so that the modular air supply units may be arranged in series with a separate conveyor and heat shroud to produce a heat tunnel of variable length, so that the length of the heat tunnel may be adjusted to correspond to the speed of incoming articles, providing sufficient time for the articles to reach the shrinking temperature of the shrink wrap film and for the shrink-wrap film to shrink around the articles.

Brief Description of Drawings

FIG. 1 is a perspective conceptual view of a packaging apparatus of the prior art.

FIG. 2 shows another embodiment of the prior art apparatus of Fig. 1.

FIG. 3 is a perspective conceptual view of the apparatus of the present invention.

FIG. 4 is a front perspective view of the apparatus of the present invention.

FIG. 5 is an exploded perspective view of the apparatus of the present invention.

FIG. 6 is a side elevational view of the apparatus of the present invention.

FIG. 7 is a perspective view of an air supply unit of the present invention.

FIG. 8 is an exploded perspective view of an air supply unit of the present invention.

FIG. 9 is a top plan view of a conveyor chain and heated air plenum of the prior art.

FIG. 10 is a top plan view of a conveyor chain and heated air plenum of the present invention.

FIG. 11a is a front elevational view of the apparatus of the present invention.

FIG. 11b is a detailed view of the indicated area in Fig. 11a.

FIG. 12 is a side elevational view of an air supply unit of the present invention.

FIG. 13a is a perspective view of a second embodiment of the apparatus of the present invention, with side-by-side conveyor chains.

FIG. 13b is a front elevational view of the apparatus of Fig. 13a.

FIG. 13C is a detailed view of the indicated area of Fig. 13b.

FIG. 14 is a perspective view of a heat tunnel using the embodiment of Fig. 13a.

FIG. 15 is similar to Fig. 14, but in addition shows articles being shrink-wrapped within the heat tunnel.

FIG. 16 is a perspective view of the heated air plenum of the present invention showing an embodiment with nozzles about the apertures.

FIGS. 17-20 are perspective views of the present invention showing the use of an optional film separator.

FIG. 21 is a perspective view through the heated air plenum showing another embodiment of the invention with air lanes.

FIG. 22 is a perspective view of the embodiment of Fig. 21.

FIG. 23 is a cross-sectional view taken at approximately the lines 23 of Fig. 21.

Detailed Description of the Preferred Embodiment

In one aspect, the present invention is an apparatus 10 for applying heat to articles A to enclose the articles A in shrink-wrap film F.

The apparatus 10 (Figs. 4, 5, and 6) comprises a conveyor 12 having a plurality of first apertures 14 therethrough. A motor 16 drives the conveyor in a first direction as shown by the arrows in Fig. 5.

The apparatus 10 further comprises a source 18 of heated air. The apparatus 10 further comprises (Fig. 7) a heated air plenum 20 under the conveyor 12 and supporting the conveyor 12, the plenum 20 having a top surface 22 having a plurality of second apertures 24 therethrough. Applicant has found that an optimal size for the second apertures 24 is about 7/16" to 7/32". In this range, the flow of heated air through the apertures 24 is much less turbulent than with either larger or smaller aperture sizes. Specifically, this range of aperture size creates primarily a vertical air flow, while larger aperture sizes allow horizontal flow.

The apparatus 10 further comprises (Fig. 8) a fan 26 blowing heated air from the source of heated air 18 through the heated air plenum 20, through the second apertures 24, and through the first apertures 14.

The apparatus 10 further comprises a return air plenum 30 returning air to source of heated air 18.

The apparatus 10 further comprises a shroud 32 partially enclosing the conveyor 12 along the first direction and spaced from the conveyor 12 at a displacement, forming with the conveyor 12 a film shrinking area 34 between the conveyor 12 and the shroud 32 (Fig. 14).

In one embodiment, the heated air plenum 20 further comprises a bottom surface 25 spaced from and opposing the top surface 22 and forming a duct 36 therebetween. The duct 36 has a height 38, and the height 38 progressively decreases along the first direction, as best seen in Figs. 6 and 12.

In one embodiment (Fig. 10), the first apertures 14 and second apertures 24 are in substantial alignment as the conveyor 12 moves along the first direction. This structure is significantly different from the prior art (Fig. 9) in which the first apertures 14 and second apertures 24 are substantially unaligned. By having the first apertures 14 and second apertures 24 in substantial alignment, the heated air passing therethrough only heats the

conveyor when the two sets of apertures are unaligned. This creates a lower temperature on the conveyor, which has important consequences as will be discussed below.

In one embodiment, the apparatus 10 further comprises a conveyor cooling fan 40 which also aids in keeping the temperature of the conveyor significantly lower than in earlier devices.

In one embodiment, the apparatus 10 further comprises a side air duct 50 adjacent the conveyor 12 along the first direction, the side air duct 50 transmitting heated air from the heated air plenum 20. The side air duct 50 may optionally have a supplemental heat source 52 (Fig. 11b), which may be an electrical heater.

In one embodiment (Figs. 13a-13c, 14, 15), the apparatus 10 further comprises at least two side-by-side conveyor chains 12a,12b running along the first direction.

In one embodiment (Figs. 13a-13c, 14, 15), the apparatus 10 further comprises a center air duct 54 transmitting heated air from the heated air plenum 20. The center air duct 54 may optionally have a supplemental heat source 56, which may be an electrical heater.

In one embodiment (Fig. 5), the displacement 60 at which the shroud 32 is spaced from the conveyor 12 is variable, thereby accomodating articles of various sizes. In such case, the apparatus 10 further comprises a means 62 for varying the displacement 60. The means 62 may either be manual (e.g., a crank or screw) or it may be automatic (e.g., by a motor 62a).

In one aspect, the present invention is a heat tunnel 110 for applying heated air to articles A to enclose the articles A in shrink-wrap film F.

The apparatus 110 (Figs. 4, 5, 6, and 10)comprises a moving conveyor chain 112 having a plurality of first apertures 14 therethrough separated by link bars 15.

The apparatus 110 further comprises a source 18 of heated air. The apparatus 110 further comprises (Fig. 7) a heated air plenum 20 under the conveyor chain 112 and supporting the conveyor chain 112, the plenum 20 having a top surface 22 having a plurality of second apertures 24 therethrough. Applicant has found that an optimal size for the second apertures 24 is about 7/16" to 7/32". In this range, the flow of heated air through the apertures 24 is much less turbulent than with either larger or smaller aperture sizes. Specifically, this range of aperture size creates primarily a vertical air flow, while larger aperture sizes allow horizontal flow.

In one embodiment (Fig. 10), the first apertures 14 and second apertures 24 are in substantial alignment as the conveyor chain 112 moves along the first direction. This structure is significantly different from the prior art (Fig. 9) in which the first apertures 14 and second apertures 24 are substantially unaligned. By having the first apertures 14 and second apertures 24 in substantial alignment, the heated air passing therethrough only heats the conveyor when the two sets of apertures are unaligned. This creates a lower temperature on the conveyor, which has important consequences as will be discussed below.

In one embodiment, the apparatus 110 further comprises a side air duct 50 adjacent transmitting heated air from the heated air plenum 20 transversely across the conveyor chain 112. The side air duct 50 may optionally have a supplemental heat source 52 (Fig. 11b), which may be an electrical heater.

The apparatus 110 further comprises a return air plenum 30 returning air to source of heated air 18.

The apparatus 110 further comprises a shroud 32 partially enclosing the conveyor chain 112 and spaced from the conveyor chain 112, forming with the conveyor chain 112 a film shrinking area 34 between the conveyor chain 112 and the shroud 32.

In one embodiment, the heated air plenum 20 is tapered vertically along the conveyor chain 112 in the direction of movement of the conveyor chain, as best seen in Figs. 6 and 12.

In one embodiment (Figs. 13a-13c), the apparatus 110 further comprises at least one additional conveyor chain 12b.

In one embodiment (Figs. 13a-13c, 14, 15), the apparatus 110 further comprises a center air duct 54 between the conveyor chains 12a, 12b transmitting heated air from the heated air plenum 20 transversely across the conveyor chains. The center air duct 54 may optionally have a supplemental heat source 56, which may be an electrical heater.

In one embodiment (Fig. 5), the spacing 60 between the shroud 32 and the conveyor chain 112 is variable, thereby accomodating articles of various sizes. In such case, the apparatus 110 further comprises a motor 62a for lowering and raising the shroud 32 relative to the conveyor chain 112.

In one aspect, the invention is a heat tunnel 210 (Fig. 4) for applying heated air to articles enclosed in shrink-wrap film, the heat tunnel comprising at least one air supply unit 220, a conveyor chain 112, and a heat shroud 32 spaced from the conveyor chain 112,

wherein multiple air supply units 220 can be provided along the conveyor chain 112 to create a heat tunnel of desired length. The air supply unit 220 further comprises a source of heated air 18, a fan 26, a heated air plenum 20, air ducts 50, and a return air plenum 30.

In one embodiment, the heated air plenum 20 is tapered vertically along the conveyor chain 112 in the direction of the conveyor chain, as best seen in Figs. 6 and 12.

In one embodiment (Figs. 13a-13c), the apparatus 210 further comprises at least one additional conveyor chain 12b.

In one embodiment (Figs. 13a-13c, 14, 15), the apparatus 210 further comprises a center air duct 54 between the conveyor chains 12a, 12b transmitting heated air from the heated air plenum 20 transversely across the conveyor chains. The center air duct 54 may optionally have a supplemental heat source 56, which may be an electrical heater.

In one embodiment (Fig. 5), the spacing 60 between the shroud 32 and the conveyor chain 112 is variable, thereby accomodating articles of various sizes. In such case, the apparatus 210 further comprises a motor 62a for lowering and raising the shroud 32 relative to the conveyor chain 112. The means 62 may either be manual (e.g., a crank or screw) or it may be automatic (e.g., by a motor 62a).

The apparatus 210 (Figs. 4, 5, 6, and 10) comprises a moving conveyor chain 112 having a plurality of first apertures 14 therethrough separated by link bars 15. The plenum 20 has a top surface 22 having a plurality of second apertures 24 therethrough. Applicant has found that an optimal size for the second apertures 24 is about 7/16" to 7/32". In this range, the flow of heated air through the apertures 24 is much less turbulent than with either larger or smaller aperture sizes. Specifically, this range of aperture size creates primarily a vertical air flow, while larger aperture sizes allow horizontal flow.

In one embodiment (Fig. 10), the first apertures 14 and second apertures 24 are in substantial alignment as the conveyor chain 112 moves along the first direction. This structure is significantly different from the prior art (Fig. 9) in which the first apertures 14 and second apertures 24 are substantially unaligned. By having the first apertures 14 and second apertures 24 in substantial alignment, the heated air passing therethrough only heats the conveyor when the two sets of apertures are unaligned. This creates a lower temperature on the conveyor, which has important consequences as will be discussed below.

In one embodiment, the source of heated air 18 is removable from the air supply unit.

In one embodiment, the source of heated air 18 is controlled to maintain a constant temperature in the heated air plenum.

In one embodiment, the apparatus 210 further comprises a sensor 230 (Fig. 6) in the heated air plenum 20 after the fan 26, the sensor 230 controlling the temperature of the source of heated air 18.

In one embodiment, the fan 26 has a variable speed to adjust the flow of heated air through the heated air plenum 20.

In one embodiment, the fan 26 is removable from the air supply unit 220.

In one embodiment, the apparatus 210 further comprises a side air duct 50 adjacent transmitting heated air from the heated air plenum 20 transversely across the conveyor chain 112. The side air duct 50 may optionally have a supplemental heat source 52 (Fig. 11b), which may be an electrical heater.

In one embodiment, the side air duct 50 has an adjustable opening.

In one embodiment, the side air duct has a diffuser 51.

In one aspect, the invention is a modular air supply unit 220 for a heat tunnel for applying heated air to articles enclosed in shrink-wrap film, the air supply unit 220 comprising a source of heated air 18, a fan 26, a heated air plenum 20, air ducts 50, and a return air plenum 30, the fan 26 blowing heated air from the source of heated air 18 along the heated air plenum 20.

In one embodiment, a plurality of the modular air supply units may be serially arranged thereby producing a heat tunnel of variable length, as best seen in Figs. 4, 5, and 6.

In one embodiment, the heated air plenum 20 is tapered in cross section transversely to the direction of heated air movement with the cross sectional area of the plenum progressively decreasing away from the fan 26 as best seen in Figs. 6 and 12.

In one embodiment, the modular air supply unit 220 further comprises a retractable center air duct 54 receiving heated air from the heated air plenum.

In one embodiment, a supplemental heat source 56 is provided for the center air duct 54.

Operation of the invention will now be described in reference to the Figures.

Articles A to be shrink-wrapped are received on an infeed conveyor (not shown) with the shrink-wrap film positioned about the articles illustratively shown in Fig. 3. Although Fig. 3 shows the articles enclosed in shrink-wrap film 21 which has been pre-perforated, any type of shrink-wrap film may be used to enclose the articles.

Articles then move from the infeed conveyor to the conveyor 12, 112 as in Fig. 3 and enter the heat tunnel, generically shown in Fig. 3 as reference numeral 10.

In the case of the various aspects of the present invention, articles move along the conveyor 12, 112 within the heat tunnel 10, 110. As they do so, heated air from the source of heated air 18 is driven by the fan 26 along the heated air plenum 20. Heated air then exits the heated air plenum through the second apertures 24. As the conveyor 12, 112 moves along the heated air plenum 20, the first apertures 14, which are in substantial alignment with the second apertures 24, allow heated air to directly contact the shrink-wrap film under the articles, producing an air weld. Because the heated air does not contact the conveyor chain 112 except at the link bars 15 (as shown in Fig. 10), the conveyor chain 112 remains much cooler than in previous devices. This prevents the shrink-wrap film from sticking to the conveyor chain 112. The lower chain temperature also allows the film lap seam under the articles to be welded by the hot air, rather than by the hot chain, producing an undesirable chain weld. In addition, this prevents the chain itself from robbing heat from the heated air, so that the heated air produces a more efficient air weld on the shrink-wrap film. Another benefit is that the conveyor chain has a longer service life. A cooling fan for the conveyor chain 112 may also be provided to increase these benefits.

As the heated air moves through the heated air plenum 20 away from the fan 26, an amount of air volume is lost out of each of the second apertures 24 in the top surface 22 of the plenum 20. To maintain constant air pressure, the volume of the plenum 20 needs to be reduced accordingly before the next set of apertures 24. The present invention decreases the cross sectional area of the plenum 20 away from the fan 26, thereby adjusting the volume of the plenum in order to keep relatively constant pressure across the length of the plenum.

As heated air moves through the second apertures 24 and first apertures 14, the specific size of the second apertures 24 and the alignment with the first apertures 14 produces significantly less turbulence in the heated air, so that a substantially vertical laminar air flow is produced. This in turn causes less fluttering of the shrink-wrap film, resulting in more aesthetically pleasing bulls eyes.

In the case in which the articles are enclosed within shrink-wrap film such that the open ends of the shrink-wrap film are oriented transversely across the conveyor 12, 112, side air ducts 50 provided heated air directed at these openings.

In the case in which the conveyor is split into two side-by-side chains 12a, 12b, an optional, retractable center air duct 54 is provided to direct heated air at the open ends of the shrink-wrap film facing the center of the conveyor chain 112.

Both the side air duct 50 and the center air duct 54 may be provided with an adjustable opening to adjust the volume of heated air flowing out. In addition, a nozzle or diffuser may be provided to direct the heated air at the articles.

The spacing between the heat shroud 32 and the conveyor 12 may be vertically adjusted to accommodate various size articles and most efficiently shrink them. This can be done with a lift mechanism 62 either manually or automatically by a motor 62A.

Modular air supply units 220 that include the source of heated air 18, the fan 26, the heated air plenum 20, the air ducts 50, and the return air plenum, can be serially arranged to produce a heat tunnel of variable length, with the conveyor 12 and the shroud 32 arranged over the air supply units 220. By allowing the length of the heat tunnel to be varied, the film shrinking process can be optimally adjusted for the speed of incoming articles.

Further improvements include the ability to maintain the source of heated air 18 at a constant temperature in the heated air plenum 20. This can be done by providing a sensor 230 (Fig. 6) in the hot air plenum 20, the sensor controlling the temperature of the source of heated air 18. The speed of the fan 26 may be variable to adjust the flow of heated air through the heated air plenum 20.

A number of serviceability improvements are included in the invention. The source of heated air 18 can be removed from the air supply unit 220 for service and/or replacement, as can the fan 26. In addition, an entire air supply unit 220 can be removed from the heat tunnel and replaced.

In another embodiment, the second apertures 24 may have small nozzles 24A (Fig. 16). The nozzles 24A increase the length of the aperture 24 and reduce the amount of horizontal air flow that is allowed to exit the aperture 24. The resulting flow from the apertures 24 is thus more vertical, causing less disturbance to the shrink wrap film.

In another embodiment, an optional film separator 250 may be added at the infeed end of the heat tunnel as shown in Figures 17-20. The film separator 250 ensures that the film of adjacent packages does not melt and stick together. The film separator 250 extends into the heat tunnel far enough to ensure that the lower portion of the unsupported film, which extends beyond the articles, has started to shrink and draw away from that of the adjacent package. The separator 250 can be mounted on top of the conveyor chain 112 (Figs. 17-18) or it may be mounted between a set of conveyor chains 112a, 112b (Figs. 19-20).

In another embodiment (Figs. 21-23), an airflow control mechanism 260 may be added to the heated air plenum 20 to vary the amount of heated air sent through the second apertures 24 across the width of the plenum 20. It has been found that, in the case of perforated film, the amount of airflow required to separate the film at the perforation may be too much for the bottom of the package. This may cause excessive shrink and create holes in the film. The airflow control mechanism 260 preferably comprises air lanes 262 in the heated air plenum 20 under the conveyor 12. These air lanes 262 will provide heated air to one or more columns of the second apertures 24 across the width of the plenum 20. Furthermore, the amount of air supplied to each air lane 262 may be independently adjustable through the use of one or more baffles 264. In the usual case, the air lanes 262a under the weakened film and on either side of the outer packages will be open to allow maximum energy through the conveyor 12 in order to separate the packages and shrink the film. However, the lanes 262b directly underneath the packages will be restricted so that the lap seam on the bottom of the package is still welded, but the film is not damaged due to excessive heat. It should be understood that the drawings represent one example of the use of air lanes, and that other baffle configurations are contemplated to be within the scope of the invention.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiment be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.